

International Space Station (ISS)
Response to
the
Cost Assessment And Validation Task Force
on the ISS

June 15, 1998

NASA Response to the Report of the Cost Assessment and Validation Task Force

Introduction

In developing the FY 1999 budget request for the International Space Station (ISS), NASA identified specific areas of increased risk exposure over the remaining development portion of the program, which were then incorporated into the budget submit. The identification of these risk areas, coupled with Congressional concern about increased costs, prompted NASA to request an independent assessment of ISS cost factors as a means of assessing and validating its cost projections. An independent Cost Assessment and Validation (CAV) Task Force, chaired by Mr. Jay Chabrow and reporting through the NASA Advisory Council (NAC), was established and held its first meeting on November 1997.

The CAV Task Force was provided open access to every facet of the ISS Program, focusing on the Program's past performance to cost and schedule targets, current performance, and future cost and schedule projections. It identified and evaluated major risk elements that would likely contribute to cost and schedule growth. The CAV's findings and recommendations were published in a report that was formally transmitted by the NASA Advisory Council to NASA Administrator Daniel S. Goldin on March 21, 1998.

The Task Force report specifically highlighted the extraordinary level of complexity inherent in the ISS Program and praised the management team as being "diligent and resourceful in managing the unique challenges of this international partnership." The Task Force concluded that the Program had made "notable and reasonable progress over the past four years" and faced no extraordinary or programmatic "show-stoppers." Nonetheless, the report concluded that Program cost and schedule projections were optimistic given the challenges which lay ahead, particularly due to the uncertain status of the Russian contributions.

Executive Summary

The CAV report recommended that program and budget planning take into account the probability of the development schedule extending an additional two years beyond the December 2003 completion of assembly date carried in the Revision C schedule of the ISS Assembly Sequence, and a need for increased annual funding of between \$130 million and \$250 million per year against the funding plan recommended in the NASA FY 1999 Budget recommendations to the Congress. Collectively, the annual funding increases recommended by the CAV total just over \$1.1 billion dollars through 2005.

The Cost Assessment and Validation (CAV) Task Force report contains nine recommendations which would mitigate further cost growth or schedule erosion. In addition to these nine recommendations, there are a number of findings described in the report. The Administrator requested that the ISS Program review each of these recommendations and findings to determine: the assumptions on which they were premised; whether they were based on information that is still current; the adequacy of current mitigation activities; and, whether alternative mitigation activities could be implemented. Against these, the Administrator tasked the ISS Program Management with defining possible ameliorative actions.

In general, the ISS Program Management has reported back in agreement with the CAV Task Force analysis, with some exceptions, and concluded the CAV had identified valid areas of cost, schedule, and programmatic risk to the program.

Prior to reporting the Program Management's specific response to the CAV report, it is worth noting that in the time since the CAV report was received and the preparation of this response, the ISS assembly sequence was revised to accommodate a four month Service Module (SM) schedule slip. The first-element launch of ISS is now scheduled for November 1998, with Development Complete scheduled for November 2002, and Assembly Complete scheduled for January 2004. The agreement of the international partners to adjust the assembly sequence mitigates, to an extent, some of the schedule risk identified by the CAV Task Force.

A key question to be answered was what additional funds would be necessary if there were a decision to "buy down" the risk exposure identified in the CAV report. If taken, such actions would work to limit the range of potential schedule slippages. Consequently, the Program Management reassessed the NASA Program budget provided to the Congress in the FY 1999 budget request, taking into account the reduction in FY 1998 funding levels -- from an increase of \$200 million in the request to an enacted level of \$90 million in the supplemental appropriation. This reassessment considered the adequacy of the baselined level of mitigation activities through 2004.

This Program reassessment concluded that the combined availability of the \$90 million transferred in FY 1998 and the full FY 1999 request provided sufficient funds in FY 1999. However, with regard to future years -- FY 2000 through 2004 -- the Program reassessment concluded additional funds could be required. A rough order of magnitude (ROM) calculation resulted in an estimate of up to an additional \$1.4 billion over the timeframe. This total includes up to \$550 million for increased risk mitigation, \$540 million for schedule protection, and \$300 million for Crew Return Vehicle (CRV) development and operations over the FY 2000 to FY 2004 timeframe. This sum could be greater than the estimate in the CAV report of an additional \$1.0 billion funding through FY 2004. Two specifics account for the majority of the difference: (1) provision for obsolescence-induced upgrades and (2) a revised assessment of the funding risk associated with the Crew Return Vehicle's development estimate, given the relative immaturity of the CRV estimate. The CAV report did not include a specific estimate for obsolescence-induced upgrades but indicated the cost would be "major".

A critical finding of the CAV Report dealt with the program risk assumed by reliance on Russian-provided hardware and support. To reduce the risk further, the CAV Task Force identified actions which could be taken to supplement those previously initiated by the U.S. In particular, the report advocated the development of an independent U.S. reboost/orbital maintenance capability such as would be provided by a "propulsion module." No specific funding augmentation was identified by the CAV for this purpose. The Program Management has considered this finding and concluded that a U.S. propulsion module as recommended could not be undertaken within the funding levels currently planned for Russian Program Assurance. The ROM estimate for this amounts to \$790 million through FY 2004, and could provide for: a long-term U.S. propulsion capability, protection against further slips in the Russian deliverables, and procurement of Soyuz crew return vehicles to assure a six person return capability when assured crew return is a U.S. responsibility, prior to the projected availability of a U.S.-developed CRV. The fiscal year phasing for some of these options could require up to \$100-150 million in FY 1999. Absorption of this funding within the current NASA budget request for the ISS in FY 1999 requires the assumption of a certain level of risk, that

is, the recognition that funding constraints from inadequate reserves could limit future responses to unanticipated events. Consequently, lower cost options are being assessed.

The ISS Program Management has initiated a process to refine and validate these rough order of magnitude estimates with the objective of having more reliable estimates and possible alternatives available for review by the Administration as part of the FY 2000 budget formulation process.

Recommendation-Action Summary

A summary of the nine CAV recommendations, with Program actions to be taken and their respective cost estimates are summarized below:

- 1) Revise the program plan to fit the financial resources available. Realistic major milestone dates should be established as the basis for development of the program plan and internally defined target dates should be used for execution.

ISS action: Program Management has generated a funding profile that would cover schedule erosion of up to one year and that would increase the level of Program unencumbered reserves from \$200 million to \$300 million annually. This level of funding would provide protection against schedule erosion and allow necessary flexibility to implement appropriate risk mitigation activities. This estimate will be refined and validated over the summer as part of the FY 2000 budget development process.

Estimated cost: Up to \$840 million, FY 2000-2004

- 2) Develop and implement a comprehensive cost and schedule risk evaluation and mitigation strategy associated with the delivery of Russian contributions, particularly for the uncertainties associated with propulsion and logistics capability and the Service Module.

ISS action: Program Management has generated a program plan which could result in the FY 1999 long lead initiation for development of an alternative propulsion capability for the ISS. The estimates also include funding for one year of additional schedule protection beyond that identified in item one above, for the specific objective of absorbing Russian related schedule erosion and impacts to the assembly sequence. A critical decision tree will be generated to identify decision milestones and refine cost implications.

Estimated cost: Up to \$790 million, FY 1999-2004

- 3) Develop and implement Phase III Multi Element Integrated Testing (MEIT) to mitigate on-orbit systems assembly and integration uncertainties.

ISS action: Technical definition monies for implementation of MEIT for ISS Phase III have been approved and are proceeding in phases as requirements mature. Discussions are being initiated to bring the International Partners into the MEIT process.

Estimated cost: Within FY 1999 budget request funding levels

- 4) Consider merging the NASA X-38 and the CRV development programs, accelerating the start of the CRV to FY 1999, and increasing the budget by \$120 million.

ISS action: The present CRV plan uses X-38 experience to mitigate technical risks associated with CRV Development. A funding reassessment has indicated additional funds could be needed to enhance reserves and to cover CRV operations items which have been underestimated. The

accelerated schedule identified by the CAV would require a premature decision with regard to the X-38.

Estimated cost: Up to \$300 million, FY 200-2004

- 5) Establish a specific organization and management structure with responsibility for Systems Engineering & Integration (SE&I) efforts, including sustaining engineering. Systems integration responsibilities should also clearly delineate and documented.

ISS action: The program has initiated a study of the organizational structure and processes implemented on the Viking Program, as recommended, for advantages that might be transferable to ISS. A development-to-integration-to-maintenance transition plan will be developed.

Estimated cost: Within FY 1999 budget request funding levels

- 6) Establish a competitive environment for support contracts, such as sustaining engineering, in order to reduce overall program costs.

ISS action: ISS contracts are awarded in accordance with the FAR. Although Sustaining Engineering is likely to be a Prime contractor function through the on-orbit performance validation period, competitive award of future contracts would be in NASA's best interest.

Estimated cost: Within FY 1999 budget request funding levels

- 7) Maintain the current level of research funding. Develop plans to maximize science utilization on-orbit during schedule stretchout.

ISS action: The ISS Program could add research utilization on orbit during schedule "stretchout." to minimize schedule risk to the research community.

Estimated cost: Up to \$150 million, FY 2000-2004, for three new missions

- 8) Institute a system for determination of earned value performance measurement for the Non-Prime scope of effort.

ISS action: The Program recommends that no action be taken. Earned value is in place for about 25% of the nonprime effort. The Program is utilizing other management tools/processes to provide effective and suitable visibility into non-prime activities.

Estimated cost: Within FY 1999 budget request funding levels

- 9) Verify the appropriateness of a flat funding profile for the operations timeframe of the ISS, specifically assessing how obsolescence-induced upgrades will be planned and implemented.

ISS action: The adequacy of the \$1.3 billion operations era budget, including a robust pre-planned product improvement program, is being assessed as part of the Agency's Program Operations Plan (POP) process leading up to its submission to the OMB this fall.

Estimated cost: up to \$100 million, FY 2000-2004

Detailed Responses to CAV Recommendations/Findings

In addition to the nine recommendations, there are a number of findings contained within the CAV report. NASA has numbered these findings in order to designate and track them. The CAV team did not provide these designators.

All of the findings very closely parallel one or more of the recommendations. This response answers the recommendation first and only responds to the findings which are distinct items. For each recommendation we have evaluated the assumptions of the team, the current mitigation activities and the possible additional mitigation actions which could be taken.

Recommendation 1: *“The present program plan should be revised so that it is achievable within the financial resources available. Realistic major milestone dates should be established as the basis for development of the program plan and internally defined target dates should be used for execution. If necessary, program content should be eliminated or deferred to fit within funding constraints.”*

(1) What assumptions were used to derive this finding/recommendation?

This recommendation is based on information obtained from numerous Program briefings, trend data, attendance at specific Program meetings, and from interviews with various Program personnel over the duration of the review. The fiscal year 1999 budget submit to Congress and Revision C of the Assembly sequence were considered by the CAV as the Program baseline cost and schedule targets.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

Yes, Revision C of the assembly sequence and the FY 1999 Congressional budget submit did represent the Program baseline at the time of the CAV review. The Program recognizes that its assembly schedules have been, and are, aggressively planned. The FY 1999 Congressional budget submit revised cost projections through assembly complete, and provided funding coverage for the recently baselined Revision D assembly sequence. However, in light of continued Russian funding shortfalls, U.S. schedule erosion and higher than projected carryover into FY 1999, and a Program reassessment based on the major risk elements identified in the CAV report, cost and schedule targets may need to be revised.

Over the life of the Program there will unquestionably be additional delays. Due to mitigating factors which are identified in NASA's response to the detailed level CAV recommendations, the Program has a high certainty that future schedule erosion will be less than the CAV projected. There is, however, a philosophical difference of opinion with the CAV on how to incorporate schedule margin into the Program to account for future risks.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

A revised assembly sequence, incorporating a four month slip to the Service Module and providing U.S. schedule relief has just been baselined. A number of mitigation activities under consideration are also identified in the finding responses that follow below.

(4) What actions could the Program take - given funding and schedule - to reduce the risk?

See detailed finding responses provided below.

(5) What are the recommended actions to be taken or justification if no action is required?

The CAV report highlights the need to adequately convey realistic cost and schedule expectations to external parties. While the Program believes it would be confusing to carry internal and external launch dates as the CAV recommends, it does recognize that some schedule erosion will occur over the five and a half year assembly timeframe. The Program could request additional funds of up to \$540 million for FY 2000-2004 to cover one year of schedule slippage through assembly complete. The Program also agrees that additional funding could be required to cover other risk mitigation activities of up.

Finding R1a: page 3, section 1.3.1 Development, paragraphs 2-4

ISS Program management, primarily due to past annual funding constraints, has not fully developed and implemented cost and schedule risk mitigation plans...”

(1) What assumptions were used to derive this finding/recommendation?

Many of the major risk elements identified in the CAV report stem from past problems that continue to trouble the Program. The continued high degree of dependency on Russian systems was identified by the CAV Task Force as the area of most concern.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

The Program agrees with this finding. NASA’s approach to minimize total ISS development expenditures has constrained funds available for activities such as parallel technology development, destructive testing, multiple source contracting, and other risk mitigation activities. However, the design maturity of the hardware is such that many of these activities are not considered necessary to mitigate development risk. An “in-line” risk management approach has been implemented across the Program, keeping accountability, active risk management and risk reduction at the line level. Risks are integrated, and prioritized in a Program-wide risk database for management awareness, status and action.

There have been instances where U.S. development risk reduction efforts and lessons learned have not resolved or eliminated risks, an example of such being the high number of parts shortages currently existing on the SO Truss. However, these cases are for the most part due to entirely different circumstances than that of previous occurrences. There have been no technological show stoppers to date, and the Program’s cost-minded approach has proved itself effective. The situation relative to risk mitigation to protect against Russian delays is entirely another matter and is addressed in the response to CAV recommendation number two.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

Development risk mitigation efforts have focused on assuring that the Space Station works properly on orbit. Incorporation of thorough Multi-element Integration Testing will significantly mitigate the risk of launching ISS Elements and then identifying costly problems on orbit. The Program is also, through an initial \$30 million dollar capital investment by Boeing, implementing an ISS systems integration lab that will increase mission success probability and enhance our capability to troubleshoot in-flight anomalies, and implementing many other mitigation activities. Two areas where the Program is developing parallel technologies are the TransHab, an alternative to the U.S. Hab module with the potential to increase volume and safety, and the Advanced Closed Loop Environmental Control and Life Support systems which advances water processing, carbon dioxide removal and oxygen generation to reduce operations cost and increased self sufficiency.

(4) What actions could the Program take - given funding and schedule - to reduce the risk?

The Program has reviewed its risk mitigation activities, taking into consideration the CAV recommendations and may augment its risk mitigation efforts.

(5) What are the recommended actions to be taken or justification if no action is required?

Additional risk mitigation could require up to \$550 million for FY 2000-2004 and will be considered as part of NASA’s FY 2000 budget request.

Finding R1b: page 3, Major Development Risk Elements: Hardware Qualification Testing; page 23, section 3.2.3 Hardware Qualification Testing

“... much of the hardware and software production is behind plan or still undergoing development and qualification testing. ... Additional cost growth potential ... [exists] as the Program completes qualification, integration, and verification testing activities.”

(1) What assumptions were used to derive this finding/recommendation?

At the time of the CAV report: the Prime contractor was behind schedule by over five weeks of scheduled effort, discounting the Program rebaselining which was in the process of being implemented. Also, less than a third of the qualification testing for ISS Phase II flights had been completed and there were multiple examples of engineering models being used in lieu of flight equipment and unqualified flight units being integrated into flight elements.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

The program agrees that late qualification of hardware does introduce cost and schedule risk, but to a lesser extent than assessed by the CAV.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

There are four factors mitigating the risk identified. First, the CAV did not take into consideration that the Program was in the process of adjusting schedules due to the Russian Service Module, providing approximately four months additional schedule time to complete qualification testing and resolve other problems. The risk arising from late qualifications, being non-additive to that originating from the Service Module, has thus been reduced significantly. Second, while qualification testing is late in many cases, there have not been a large number of significant problems identified. The long design and development period resulting from use of over 75 % of the Space Station Freedom heritage is resulting in hardware that is designed correctly, extensively tested, and which will meet the Program's operational requirements. The hardware's design heritage may not have been given adequate consideration by the CAV. Third, trend analysis of flight and qualification hardware deliveries have shown improved schedule stability over the last six months, reflecting less slippage than previous trends presented to the CAV. Finally, the ISS has also enhanced its testing capacity in various areas such as electrical orbital replacement units to mitigate qualification delays.

(4) What actions could the Program take - given funding and schedule - to reduce the risk?

This risk is driven by schedule under-performance, which NASA and Boeing have taken action to reduce and which reserves have already increased in the FY 1999 budget submit to Congress. The Program can budget additional resources to cover under-performance and maintain necessary development staff to minimize future schedule impacts.

(5) What are the recommend actions to be taken or justification if no action is required?

The Program will increase budget reserves in the FY 2000 Budget request to continue work-arounds for late qualifications, managing efforts on a daily basis through control boards, status reviews and joint NASA/Contractor management meetings.

Finding R1c: page 4, Major Development Risk Elements: US Laboratory Schedule; pages 24-25, section 3.2.6 US Laboratory (Lab)

“The Laboratory is currently several months behind schedule... Considering past trends there is a high probability of additional schedule erosion of several weeks or more... Current schedule trends...indicate a three to four month negative margin at Lab completion.”

(1) What assumptions were used to derive this finding/recommendation?

The CAV used the current Lab status from the program and assessed the schedule slippage based on past schedule performance trends and a projection of time necessary for removal, rework, reinstallation and regression testing of a nominal level of components that experience anomalies.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

The CAV projection of continued schedule erosion on the Lab has already proven itself credible. An anomaly with coldplates designed to evacuate heat from laboratory equipment is likely to add as much as a month or two to the laboratory schedule. Like many of the risks identified by the CAV the impact of this delay is not serially additive to others. The Program assembly sequence revision resulting from the Service Module delay is sufficiently long to cover Lab schedule erosion and provide additional schedule Lab margin to flight.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

A Lab schedule summit was held in mid-May to status all development activities, assess threats, and review remaining risks and associated mitigation planning. The program has taken a number of steps to minimize Lab schedule erosion. Some of these activities include: daily status meetings on key components, utilizing engineering models during integrated checkout, recovery plan development, staffing increases and additional shifts, the development of new rack handling tools, and the performance of disciplined risk/benefit analysis for use of non-qualified parts during system level qualification test.

(4) What actions could the Program take - given funding and schedule - to reduce the identified risk to the Program?

Revision D to the assembly sequence provides Lab schedule relief. The program could maintain its existing, Revision C, delivery schedules in order to increase schedule reserves, and continuing to maintain a high level of management focus on Lab development activities.

(5) What is the Program’s recommendation regarding actions to be taken or justification if no action is required?

The program will continue to place major emphasis on the achievement of Lab module schedule milestones, judiciously using overtime to maintain recovery schedules, and monitoring the schedule margin and qualification test results against the revision D schedule.

Finding R1d: pages 4-5, Major Development Risk Elements: Software Development & Integration; page 23, section 3.2.4 Software Development and Integration

“The ISS has a significant amount of software that has to be. ...Late flight hardware deliveries will place further pressure on software schedules due to hardware problems likely to be discovered during late stages of testing. Typically, late hardware problems are circumvented by software work-arounds, thus increasing the time and effort required for software integration and testing..

(1) What assumptions were used to derive this finding/recommendation?

Historically, the most frequent method used to correct late flight hardware problems is to modify flight software.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

Yes, this has historically been the case.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

The Program has instituted a multifaceted approach to ensure properly functioning software and hardware/software compatibility as early as possible in the development phase. The key elements of this approach include:

- an MDM (Multiplexer Demultiplexer, the ISS standard flight computer) Application Test Environment (MATEs) for all domestic software developers for development and testing of software on a common platform,
- a thorough Interface Control Document program which requires detailed definition of all HW/HW, HW/SW, and SW/SW interfaces,
- a Software Verification Facility (SVF) which uses Flight Equivalent Unit (FEU) MDMs to test flight software against simulated interfacing elements,
- an ISS Systems Integration Lab (ISIL) which incorporates many FEU electronic boxes from all avionics subsystems,
- a Multi-element Integration Test program (MEIT) which integrates major elements of the ISS for compatibility testing prior to launch.

In combination, these items provide adequate confidence that ISS Elements will work properly together.

(4) What actions could the Program take - given funding and schedule - to reduce the risk?

As with any major technology program, there is some level of cost, schedule and technical risk commensurate with associated constraints. The level of risk on the ISS Program is considered acceptable, but, as with any program, the risk level may be reduced. In this case, the Program could improve the fidelity of the facilities listed above. In particular, the ISIL could be upgraded to more accurately emulate flight-like conditions, and the scheduled test time could be increased to accommodate more thorough testing and provide schedule margin for correction of anomalies.

(5) What are the recommended actions to be taken or justification if no action is required?

The Program will extend scheduled test time in the SVF and ISIL; and upgrade these facilities as appropriate and feasible to create more flight-like test conditions. It will also expand the level of regression testing based on rework due to hardware/software anomalies identified in testing.

Finding R1e, page 4, Major Development Risk Elements: Training Readiness Bullet; page 27, section 3.2.10 Training

“Delivery delays of both hardware and software are having a direct impact on training preparation. ... Russian and American training procedures ... differ significantly in many respects. ... There [is] no agreement to merge the training approaches into one unified program.”

(1) What assumptions were used to derive this finding/recommendation?

The CAV task force looked at known schedule problems with delivery of the Russian Segment Trainer and also some other Russian deliverables. There was also some evidence in Expedition-1 crew statements regarding lack of documentation of Russian training materials, procedures and philosophies, and the overall lack of effectiveness in these areas.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

The program agrees that there continues to be schedule risk in the training area. This is documented in the program risk process where several training risk items are identified.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

For flight software availability, access to multiple early engineering releases for each item which did not meet the original facility need date have been negotiated. For general Russian training philosophy issues, Russia recently agreed that the International Training Control Board (ITCB) be the forum for integration of all training requirements and philosophies (other partners have already agreed). NASA has also reached agreement with the Gagarin Cosmonaut Training Center (GCTC) and RSC-Energia to implement NASA-oriented lesson-by-lesson training flows and jointly developed GCTC training materials that adhere to standards and schedules in place of the traditional Russian approach.

For the delivery delays of the Russian Segment Trainer (RST), the Space Station Training Facility development team has set specific negotiations targets which will provide integration development relief to Russian Space Agency (RSA), in return for in-process reviews of model development. Also, NASA has a "safety net" approach of low-fidelity stub development which reduces SSTF integration risk, but that is hampered by lack of Russian systems data. A fall-back plan for later flights (2A-4A) reduces development dependencies on Russia, but also does not meet all multi-element training objectives. Recent improvements include the Rocket Space Corporation (RSC-Energia) agreement to provide integration support for May and August deliveries, and an additional delivery from Russia was added to the project plan.

(4) What actions could the Program take - given funding and schedule - to reduce the risk?

Reviews with various levels of ISS management are already planned to monitor the success (or lack thereof) of these initiatives. The Program could continue to identify areas of greatest concern and develop backup plans to mitigate the negative effect of schedule erosion.

(5) What are the recommended actions to be taken or justification if no action is required?

Continue to follow the risk abatement plans as currently identified in the program risk system (summarized above). As new concepts for further fallback plans are developed and approved, they will be added to the risk abatement plans in the program risk system.

Finding R1f, page 3, Findings: De-staffing; section 1.3.1 Development

Current development de-staffing plans require Prime contractor off-loads at a greater rate than all previous plans. Past trends clearly indicate that this is not a realistic assumption. Therefore, the CAV believes that attempting to adhere to the current de-staffing plans is unreasonable and will introduce additional cost and schedule risks that could otherwise be avoided.

(1) What assumptions were used to derive this finding or recommendation?

The CAV assessed trends derived from previous staffing profiles used to support Congressional budget submits for the last four years and assessed current projections against identified work and future risks.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

The Program agrees that there are both known and unknown threats that may materialize to the point of over-stressing the retained staff; a certain level of risk of this nature is expected in a cost-constrained program.

(3) What plans does the Program currently have in place which may mitigate the risk?

The de-staffing plan is tracked and reassessed on a monthly basis based on risks resulting from: program changes, test problems, late deliveries, and schedule performance. While NASA recognizes the importance of meeting the de-staffing targets, maintenance of Program schedules is of paramount importance to the success of the Program. Therefore, staffing levels will continue to be adjusted, as necessary, to retain critical skills through the completion of the required work, even if de-staffing targets are not attained. The FY 1999 budget request included additional funding coverage for potential Prime performance problems and additional contract change activity.

(4) What actions could the Program take - given funding or schedule - to mitigate the risk?

The Program could reduce the slope of the planned destaffing curve so that it corresponds to an alternate destaffing curve which assumes known threats will materialize, then add additional margin for unknown threats. The Program effectively does this on a month-by-month basis, with the increased Prime cost being accounted for in the FY 1999 submit.

(5) What are the recommended actions to be taken or justification for no action?

The Program will consider additional reserves that can be progressively applied to cover the increased staffing cost incurred should the Program experience schedule erosion of up to one year beyond the Revision D assembly milestones.

Finding R1g: page 5, Major Development Risk Elements: Parts and Spares Shortages; pages 26-27, section 3.2.9 Parts and Spares Shortages

“To contain near-term spending to within the funding profile during peak development, decisions were made to reduce contracting for parts and spares necessary to support the current schedule. Various program activities were hardware-limited during the development and test phases. Not procuring adequate spares during the initial production run of some components may lead to quality and consistency issues as well as increased cost.”

(1) What assumptions were used to derive this finding/recommendation?

The CAV was provided with a detailed briefing regarding sparing. The Program identified that this is the first NASA contract to have an integrated logistics support approach applied from inception of the program. The Task Force was also briefed on: sparing requirements to support ground and on-orbit maintenance, repair procedures, tools, storage logistics, test equipment, critical failures, budget, pre-planned product improvement, hardware availability and other considerations.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

Specific sparing requirements were not identified when the Prime contract was negotiated. Like sustaining engineering, NASA opted to wait until program definition and requirements matured. There have also been instances where late qualification test have resulted in a decision to defer spares procurements. This may have contributed to an impression that spares were not being procured due to funding constraints. There have been only a few examples identified where spares orders were deferred due to funding, however, the operational need dates for these deferred spares were supported.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

The requirements for spares and parts have been assessed against the latest assembly sequence needs and orders have been placed accordingly. Furthermore, the timing for ordering spares must carefully consider design maturity, as some of these components have not completed qualification testing. Another factor is the stability of the production lines for these parts.

(4) What actions could the Program take - given funding and schedule - to reduce the risk ?

Additional funding would allow for a more robust spares program, specifically considering age-life of subsystems as ISS reaches the end of its design life.

(5) What are the recommended actions to be taken or justification if no action is required?

The Program is currently reassesses spares requirements, specifically concerning the long lead procurement of spares given ISS age-life considerations. Any adjustments will be reflected in NASA's FY 2000 budget submit.

Recommendation 2: *“Develop and implement a comprehensive cost and schedule risk evaluation and mitigation strategy associated with the delivery of Russian contributions, particularly for the uncertainties associated with propulsion and logistics capability and the Service Module delivery.”*

(1) What assumptions were used to derive this finding/recommendation?

Russian hardware delays, leading to overall Program schedule slip, are largely due to Russian government funding shortfalls. The current Russian economic system and political uncertainties will likely continue to delay hardware deliveries and increase Program costs. Russian priorities to maintain Mir appear to conflict with their ISS commitments. There remains a concern that a diminished level of Russian participation could significantly alter the current ISS assembly sequence and the final ISS design. NASA's FY99 budget request to Congress includes Russian Program Assurance funding for a single Interim Control Module.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

The Program agrees with the Task Force's representation of historical Russian shortcomings and the potential risk to the Program of delayed Russian contributions. Despite high-level attention, a significant risk exists relative to the near-term provision of the Service Module and the long-term servicing of the International Space Station by Progress logistics flights. The desire of the Russian government to ensure adequate space agency funding may still not manifest itself in resources that are both scarce and critical to the Russian economy, and the best efforts of the Russian engineering teams may not be enough to overcome the schedule obstacles that have been incurred to date.

(3) What mitigation plans does the Program *currently* have in place to mitigate the risk?

Step One of NASA's Russian Contingency Plan was the development of an Interim Control Module (ICM). It will provide limited risk mitigation by serving as a propulsion backup for either the Service Module - allowing ISS assembly to continue through flight 7A - or for a late or non-delivery of Progress logistics flights. Modifications have also been made to the FGB to accommodate either the Service Module or the ICM to provide Program flexibility. Other preparations for late or non-delivery of Russian hardware include modifications to the FGB to allow it to be refuelable, to extend its operational life, and to increase its flexibility. The Program has also conducted various planning activities to determine further actions that could be taken if necessary. Dry cargo logistics requirements could potentially be accommodated using Shuttle reserve margins.

Relative to Mir, an agreement on Mir de-orbit planning was reached in April 1998, providing for the release of a Mir Deorbit Plan by June 1, 1998. The Russians have agreed that the ISS will have priority over Mir and while the Mir's deorbit is planned for December 1999, it could be deorbited at an earlier date, if required, to avoid a conflict of resources with the ISS.

(4) What actions could the Program take - given funding and schedule - to reduce the risk?

The Program could develop a U.S. propulsion capability in order to reduce dependency on the Service Module and downstream Progress refueling flights. Program reserves could also be augmented to reflect additional schedule slippage in order to incorporate the launch and any servicing necessary to integrate a U.S. propulsion capability into the Shuttle manifest. Additionally, the Program could budget for the procurement of a certain number of Progress flights to mitigate the logistics risk and for the procurement of Soyuz modules to mitigate CRV

schedule risk. Finally, additional Shuttle flights could be added to support dry cargo resupply requirements.

(5) What are the recommended actions to be taken or justification if no action is required?

The Program's assessment is that the risk of late or non-delivery of critical Program content warrants the implementation of additional Russian contingency activities. There are a number of options under consideration, including the development of U.S. propulsion capability. Some of these options could require as much as \$100-150 million in FY 1999.

A robust option of NASA's Russian Contingency Plan could require additional funds totaling as much as \$790 million through FY 2004 timeframe. Lower cost options will also be assessed. A critical decision tree will be developed to identify future decision milestones where additional expenditures will be needed to continue development of the U.S. propulsion capability and other contingency activities to reduce reliance on Russia. These funding requirements will be refined and validated over the summer as part of the FY 2000 budget development process.

Finding R2a: page 6, Major International Risk Elements: Russian Logistics/Propulsion Support

“...RSA plan reflects a late 1999 Mir de-orbit. This plan...foreshadows a Russian logistics impact to the current ISS assembly sequence. Russia’s demonstrated Progress spacecraft production capacity and its recent launch rate capability do not support.... ISS and Mir requirements.”

(1) What assumptions were used to derive this finding/recommendation?

Over the last few years, RSA has launched approximately six vehicles to Mir each year (2 Soyuz, 4 Progress). To support both Mir and ISS requirements, RSA would need to launch 13 vehicles (4 Soyuz, 9 Progress) in 1999, which is highly unlikely.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?
Yes

(3) What mitigation plans does the Program *currently* have in place to mitigate the risk?

If the Mir is de-orbited in the middle of 1999 (instead of the end of 1999 as currently planned), RSA could reduce the total number of launches required in 1999 by three flights. NASA and RSA signed a plan in Moscow in April 1998, which implements a review of ISS and Mir resources every 3 months. After these reviews, a decision will be made by RSA as to when the Mir will be de-orbited. The decision to de-orbit Mir by the middle of 1999 could be made as late as December 1998 given the current Mir orbital profile.

(4) What actions could the Program take - given funding and schedule - to reduce the risk?

These are some of the options under consideration. They vary in terms of ability to respond to Russian funding problems and impact to NASA

- a) Delay launch of the first ISS crew: This reduces by one the number of Progresses in '99. But, it increases risks because the crew will not be available to fix on board problems that might occur prior to flight 4A. The skip cycle propellant requirement would also be violated.
- b) Allow RSA to reduce its logistics commitment to ISS and use Progresses for delivery of only propellant to ISS: This would reduce the number of Progress flights; however, Shuttle Program dry cargo requirements would increase, resulting in assembly slippage.
- c) Attach the ICM to ISS after flight 6A and use the Shuttle to bring dry cargo: This would require additional ICM funding and would slip assembly due to Shuttle schedule impacts.
- d) The U.S. could develop additional ICM's or a propulsion module that would provide needed propulsion function for ISS.
- e) NASA could fund additional Progress launch vehicles, making appropriate adjustments to its international agreements for due consideration.
- f) Provide Shuttle reboost using excess Shuttle Reaction Control System (RCS) propellant modifications to enable forward/aft RCS tank propellant transfer which could provide significant reboost potential.
- g) Rely on European Automated Transfer Vehicle (ATV) and Japanese H-II Transfer Vehicle (HTV) for long-term support.

(5) What are the recommended actions to be taken or justification if no action is required?

The options described above will be incorporated into the critical decision tree identified in NASA's response to CAV recommendation two.

Recommendation 3: *“Develop and implement Phase III MEIT to mitigate on-orbit systems assembly and integration uncertainties.”*

(1) What assumptions were used to derive this finding/recommendation?

At the time of CAV review, detailed MEIT planning only covered Phase II of the Program. The Program informed the CAV that MEIT would be implemented for Phase III and that specific implementation options were being assessed. The funding for this effort was carried against the ISS reserves threat list. This recommendation was made as a matter of report completeness, not to identify an area of risk mitigation which the Program was unaware.

The CAV assessment that there is inadequate schedule margin to address issues raised in the MEIT testing also reflects a philosophical difference. The NASA plan does not force the schedule to slide by allocating time for issue resolution. Since successful completion of MEIT is integral to the mission success of the ISS, the Program will use the schedule necessary to fix problems. This approach does not presuppose a given level of problems.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

The Program agrees with the recommendation but takes issue with a CAV statement that MEIT is an area of inadequate contingency planning. The depth and breadth of MEIT requirements were not sufficiently defined in 1994 to negotiate an amount with the prime. There were a host of issues relative to integration and testing that it was understood would take more time to develop. After specific requirements matured, various approaches were assessed and a process was agreed upon that meets these unique requirements for Phase II of the Program.

Until specific plans and level of effort requirements to incorporate MEIT into Phase III of the Program can be identified, it is extremely difficult to modify the contract to accomplish MEIT for the entire Phase III of the ISSP. Plans for MEIT for ISS Phase III have been initiated and will be thoroughly reviewed by the ISSP before authorizing changes to the contract. We have evaluated additional snapshots in time to highlight appropriate integration tests.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

Technical definition funding for implementation of MEIT for ISS Phase III has been approved and technical definition is proceeding in phases as requirements mature.

(4) What actions could the Program take - given funding and schedule - to reduce the risk ?

The schedule concerns identified by the CAV associated with MEIT will be relieved by Revision D to the assembly sequence. Discussions are being initiated to bring the International Partners into the MEIT process.

(5) What are the recommended actions to be taken or justification if no action is required?

MEIT planning for ISS Phase III will continue as outlined above, and will formulate specific contract change orders and hold funding as a threat against reserves.

Recommendation 4: *“Consider merging the NASA X-38 and CRV development programs, accelerating the start of the CRV to FY99, and increasing the budget by \$120M.”*

(1) What assumptions were used to derive this finding/recommendation?

The CAV team assumed that the NASA provided CRV was on the critical path to allow ISS growth from a three person crew to a six and then a seven person crew. They discounted the ability to obtain an additional Soyuz spacecraft to allow six people. The team discounted this option since no firm agreement had been negotiated with Russia. In addition the CAV highlighted the short development time and lack of a clear acquisition strategy for the CRV.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

The NASA CRV will provide egress capability for the total permanent crew to return to earth. However, the provision and docking of a second Soyuz capsule to the ISS is an acceptable short term option which would allow the on-orbit crew complement to expand from three to six persons.

The Program does have concerns with the cost estimates for the CRV and the schedule for delivery. Because there is little data available to support the present budget estimate, a bottom-up costing of the CRV Development Project has been requested as part of the ISS Program's FY 2000 POP exercise. The ISSP has also asked for Program threat estimates for: the cost of an ISS-to-Earth test flight of a development CRV; the cost for each ESA contributed component should they be provided by a U. S. contractor; and the cost associated with the presently built-in capability for ELV launch. This approach is also being employed to develop the operations budget for the CRV. An independent audit of the CRV development budget is also being considered. This process will provide a sound basis for the cost estimate for the CRV development project.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

The X-38 program is the primary mitigation for the risk to the development of the CRV. As long as the X-38 prototyping work is utilized to a large extent in the CRV development many of the technical development challenges are reduced. The ISS Program Manager controls the requirements and the budget for the CRV, and is accountable for this critical ISS element.

(4) What actions could the Program take - given funding and schedule - to reduce the risk?

In the development of an acquisition strategy for the CRV, more attention could be given to the transition of the design to industry. Consideration should be given to providing more insight by industry in the CRV's development. The ISSP has examined the schedule for implementing the CRV procurement process, and it appears that current plans will support a Contract Start Date of October 1999 (FY 2000). Given the time that is currently available, and the length of the nominal procurement process, an earlier start date is unlikely .

In the POP 2000 exercise, the ISSP has asked for estimates of cost and schedule impacts in case NASA is unexpectedly required to provide one or more of the items proposed under the pending agreement with ESA .

(5) What is the Program's recommendation regarding actions to be taken or justification if no action is required?

The Program believes that the funding for the CRV could be augmented to enhance reserves and to cover underestimated CRV operations items. This additional level of funding, estimated at up to \$300 million, will be refined and validated over the summer as part of the FY 2000 budget development process.

In addition, the management of the X-38 and the CRV will be integrated in order to ensure transfer of all lessons learned from the X-38 program. The ISS Program Manager will manage the funding and the top level requirements for the CRV. Organizationally, the relationship between the CRV project Office and the ISS Program Office will be defined to a greater extent, with ISS performing inline management of the CRV development.

Recommendation 5: *“Establish a specific organization and management structure with responsibility for Systems Engineering & Integration (SE&I) efforts, including sustaining engineering.”*

(1) What assumptions were used to derive this finding/recommendation?

During Program briefings and personnel interviews, the CAV became aware of certain system integration functions which NASA was performing in a lead capacity which appeared contrary to contract documentation provided to the CAV. The CAV also did not see evidence of a clearly defined process, or plan, for the transition of hardware and software from development through integration and checkout to operations and maintenance, and the retention of people throughout the process.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

The NASA/Prime ISS contract and the Program systems integration plan recognizes NASA's considerable experience in certain disciplines and that the Prime contractor can not represent the U.S. Government in negotiations with International Partners. For this reason, NASA's active performance of certain system integration functions is entirely appropriate. The Program also agrees that a transition plan, being currently contained within different organizations and processes, has not been clearly defined.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

At this time, the management of development activities and sustaining efforts are in separate offices. This was done to provide the necessary early focus for setting up the sustaining processes. However, engineers that support both development, integration and sustaining are in a single organization; they simply charge their efforts to a different charge code depending on the work being done. As the development phase is incrementally completed critical skills will transition to sustaining engineering to support the assembly stages. In order to retain critical skills and knowledge, NASA has a process in which one team provides support to both development, integration and sustaining. For example, there will be a core group of subsystem engineers with knowledge of the power distribution system. This single group of engineers will support the development, integration, and sustaining effort for both the early and late launch elements. In order to make staffing increases or decreases to the team, the combined level of effort for both the development, integration and sustaining will be considered. In this manner, both NASA and the contractor will ensure that continuity and necessary expertise stay on the program. The program has all the sustaining engineering and integration functions today but they are not in one organization, they are spread out throughout the program.

(4) What actions could the Program take - given funding and schedule - to reduce the risk?

The program will study the organizational structure and processes implemented on the Viking Program, as recommended, for advantages that might be transferable to ISS. A development-to-integration-to-maintenance transition plan could be developed.

(5) What are the recommended actions to be taken or justification if no action is required?

The Program will develop follow on actions based on the result of the Viking program study and development-to-integration-to-maintenance transition plan.

Finding R5a: page 18, Programmatic Issues: Prime Contractor Performance;; page 23, section 3.1.2 Sustaining Engineering

The ISS Program Office has advised the Task Force of its intent to address skill-base retention through the Sustaining Engineering workforce. Given the funding constraints, however, this workforce may not be adequate to completely resolve the issue.

(1) What assumptions were used to derive this finding/recommendation?

The CAV was briefed that the Prime's estimate for sustaining engineering was over \$1.2 billion for the period FY 1997 through FY 2002. It was stated to the CAV that by industry standards the Prime estimate would be considered as low. Yet, NASA submitted an estimate for over the same timeframe to the Office of Management and Budget that was nearly \$500 million less than Boeing's estimate.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

NASA agrees with the base information provided to the CAV. The Prime estimate, based on engineering Equivalent Persons (EPs) was indeed low by industry standards. But, there are many factors to consider in the negotiation of a sustaining engineering contract, such as overhead rates, demonstrated hardware performance, technological advancement, in-house NASA experience, and many other factors. The sustaining engineering contract negotiated between NASA and the Prime contractor is based on a thorough task-by task review of all ISS systems and elements for FY 1998 and FY 1999. NASA will conduct this same type of task review for the follow-on years. Our review indicates that the currently projected level of staffing will support ISS requirements.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

An agreement has been reached for this activity in FY 1998-1999. NASA and the prime contractor are currently negotiating a contract change for the sustaining engineering effort in the subsequent years.

(4) What actions could the Program take - given funding and schedule - to reduce the risk?

Additional funding would allow more depth of experience to be retained.

(5) What are the recommended actions to be taken or justification if no action is required?

NASA and the prime contractor are in the process of negotiating the contract change for this effort in the subsequent years.

Recommendation 6: *“Establish a competitive environment for support contracts, such as sustaining engineering, in order to reduce overall program costs.”*

(1) What assumptions were used to derive this finding/recommendation?

The CAV concluded that the rates for the sustaining engineering support were excessive and made the recommendation to improve competition for all support contracts

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

In the specific example of Sustaining Engineering (SE), it is an integral portion of the prime contract. In the instance of our design, development, test, and evaluation contract with Boeing, the contract states that if NASA fails to contract with Boeing for SE (during the period of performance for the delivery of ISS assembly complete plus 12 months), the contractor's fee earned on-ground but not retained through on-orbit evaluation will not be subject to further evaluation or takeback after the date that SE is ended. We believe that early after assembly is completed the Prime will continue to be the SE contractor. We are certainly open to the possibility of different contracts after a period of time.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

NASA is working with the prime contractor to consider methods to further reduce costs, especially in the area of sustaining engineering.

(4) What actions could the Program take - given funding and schedule - to reduce the risk?

The preference is, and always has been, to competitively award all ISS requirements. Only in those circumstances where legitimate reasons exist for noncompetitively awarding contracts (e.g., only one source; international agreements) and where all the proper approvals are obtained, is competition not used.

All ISS contracts are awarded in accordance with Federal Acquisition Regulation requirements. Presently, there are 15 non-Prime contracts with a total value of \$561M. The vast majority of this award amount (\$472M) relates to a non-competitively awarded contract with RSA for joint US/Russian Human Flight Activities. Of the remaining 14 contracts, 5 contracts valued at \$30M were competed and 4 other contracts valued at \$7M were awarded under the SBA's 8(a) program for Small Disadvantaged Businesses

(5) What are the recommended actions to be taken or justification if no action is required?

The acquisition strategies for future operations contracts are currently being reviewed. The goal of the ISS Program is to competitively award all contracts when in the best interest of the Government.

Recommendation 7: *“Maintain the current level of research funding. Develop plans to maximize science utilization on-orbit during schedule stretch-out.”*

(1) What assumptions were used to derive this finding/recommendation?

The CAV team understood that previous rephasing of the research effort was, at least in part, due to a need to supplement additional reserves. The CAV understood that no research facilities were impacted by this rephasing, other than necessary adjustments to resynchronize research with on-orbit capabilities. However, the CAV felt that the research community needed stable funding to plan the implementation of research requirements.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

Yes, we believe that the research program has a balanced implementation plan and that adequate funding should be maintained.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

The research budget carries its own reserve for unanticipated requirements.

(4) What actions could the Program take - given funding and schedule - to reduce the risk?

The Program could provide separate and additional funds for research capability enhancements, technological upgrades and obsolescence. Further, reserves could be carried to provide additional non-ISS research flights on the Shuttle as a research counterbalance to the risk which would emanate from ISS schedule erosion.

(5) What are the recommended actions to be taken or justification if no action is required?

The ISS Program could add research utilization on orbit during schedule “stretchout.” Options include three new utilization missions to provide alternate research opportunities should schedule erosion occur.

Recommendation 8: *“Institute . . . [an] earned value performance measurement [system] for the Non-Prime scope of effort.”*

(1) What assumptions were used to derive this finding/recommendation?

The key assumption is that earned value reporting is appropriate for the non-prime effort. There is also a secondary assumption that the NASA centers could easily incorporate earned value reporting into their contracts at no cost if desired by the Space Station program.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

The program does not agree with all of these assumptions. Many of the contracts covering the non-prime areas of the program are fixed price, Level-Of-Effort (LOE), or recurring operations which are not suitable for earned value reporting. Since in most cases earned value reporting is not a contractual requirement, it would have to be added to the existing scope of work and there could be a substantial cost. For example, for the Shuttle Flight Operations Contract (SFOC), USA wanted \$6 million to incorporate earned value reporting and NASA determined that the costs outweighed the benefits and elected not to have it implemented.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

The program negotiates its requirements with the various NASA organizations which manage the Non-Prime effort through Technical Task Agreements (TTAs). These TTAs outline the work to be done, the schedule required, and the resources needed (both contract dollars, contract manpower, and civil service resources). Progress against the TTA spending plan is tracked monthly and reported to Space Station program management. As new work is added, it is negotiated with the non-prime performing organizations and new TTAs are written or existing agreements are modified as appropriate.

In addition to the TTAs, the program receives the monthly accounting data from Agency and field center financial records which allow the program to track non-prime progress by budget line (e.g. - development, operations, etc.) and by performing organization (JSC engineering directorate, KSC, etc.). Both dollars and contractor manpower are tracked against the plan and the program receives variance explanations from the performing organizations that allow insight into progress to date and forecast performance.

Schedules for the non-prime work, particularly Government Furnished Equipment (GFE), are input into the program's schedule data base, and the program critical path is identified. This is reported weekly and monthly to program and center management.

Earned value data are reported by contractors on 23% of the non-prime effort. The majority (55%) of the non-prime effort is for institutional changes, fixed-price Russian activities, and research activities. The remaining non-prime effort (23%) would have to be internally estimated by civil servants.

In 1995 and 1996 the program attempted to have its own civil service personnel as well as center civil service personnel internally resource load some of the top level schedules to derive earned value parameters. This resulted in two separate reporting systems that occasionally conflicted with each other. Since the work is done by field center contractors and not civil servants, it was decided that whatever insight was being provided was simply not worth the in-house effort being expended to reconcile the two systems. This was discontinued in 1997 after

reviews with NASA field center and Station management. Once the Agency moves to a full cost accounting process, visibility into the civil service component will be significantly enhanced.

(4) What actions could the Program take - given funding and schedule - to reduce the risk?

As identified in item (3) above, the Program is utilizing other management tools/processes to providing effective and suitable visibility into non-prime activities. The Agency could decide to implement earned value reporting on the non-prime cost reimbursable contracts but the centers would have to bear the cost impact. There are no fiscally prudent actions the Space Station Program could take to improve its risk posture relative to non-prime performance reporting beyond what the Program is currently receiving from the NASA centers.

(5) What are the recommended actions to be taken or justification if no action is required?

The program recommends that no action be taken. The current system of reporting on the non-prime cost and schedule performance is sufficient to satisfy the needs of the Space Station program.

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Recommendation 9: *“Verify the appropriateness of a flat funding profile for the operations time frame of the ISS, specifically assessing how obsolescence induced upgrades will be planned and implemented.”*

(1) What assumptions were used to derive this finding/recommendation?

The \$1.3 billion estimate was developed during the Space Station redesign of 1993, and represents an average annual operations cost over the ten year operational life expectancy of the Program. The CAV Task Force was not presented any specific information relative to a plan of obsolescence induced upgrades. This led to a concern that additional funding would be required.

(2) Does the Program agree? If not, what was incorrect and what is the correct information?

In general, the assumptions inherent in the original \$1.3 billion annual operations budget estimate are still valid. In fact our experience in the Shuttle - Mir program has served to validate several of our assumptions about long term operations. The \$1.3 B was an average throughout these years. The Program had always assumed that the operations funding would begin at a higher level and transition through to a lower level.

(3) What mitigation plans does the Program currently have in place to mitigate the risk?

The ISSP has a critical spares program in place which targets those areas most likely to need support. An analysis has been performed to determine the content of \$220M per year for sustaining engineering and \$70M per year for spares appears adequate. From an operational planning perspective the experience from the Shuttle-Mir program has validated many of the operations functions for long term space flight. Our recent experience negotiating the sustaining engineering addition to the Boeing contract has also provided a better insight into these functions.

(4) What actions could the Program take - given funding and schedule - to reduce the risk?

While there is \$220M / year for sustaining engineering and \$70M/ year for spares, the program does not specifically target any funds for system upgrades. These funds will only provide a limited degree of upgrade capability. They are inadequate to support a meaningful pre-planned product improvement program. Additional reserve could be included in these years to allow the development of a candidate upgrade program.

(5) What is the Program’s recommendation regarding actions to be taken?

The Program could add additional funding totaling approximately \$100M through Assembly Complete for the development of a candidate upgrade program. Some candidate technology improvements represent commercialization opportunities. Commerce Business Daily (CBD) announcements are being prepared for many of the technology improvement candidates to solicit potential interest in providing the technology improvement as a commercialization activity, and to insure that we have identified all of the promising innovative technology solutions.

The adequacy of the \$1.3 billion operations era budget is being assessed as part of the Agency’s POP process leading up to its submission to the Office of Management and Budget this fall. A detailed assessment of the additive funding necessary to maintain a robust pre-planned product improvement program will be included in the POP process.